ANNEX 1

TRENDS

The Annex lists and briefly describes the trends and conditions, which might have high impact on the relationship between ICT and higher education that were revealed during the quick scan of Foresight and Forward Looks on Higher Education in the ICT age. This list will be used as input for discussion on the Future Relationship between ICT and Higher Education. It is attempted to provide some background articles on all the trends and events that are mentioned. The author is aware that the evidence for some of the trends is still scarce and some important issues may be missing, therefore we appreciate all suggestions for the improvement of the list, preferably with documentation.

1 Societal Trends

1.1 World population growth

The world population is still growing (see the UN projection in Fig. 1). Most future studies and foresight activities using the medium fertility line as a basis predict stabilization of the world population around the year 2050 at the level of 10 to 11 billion people but with still an enormous uncertainty.

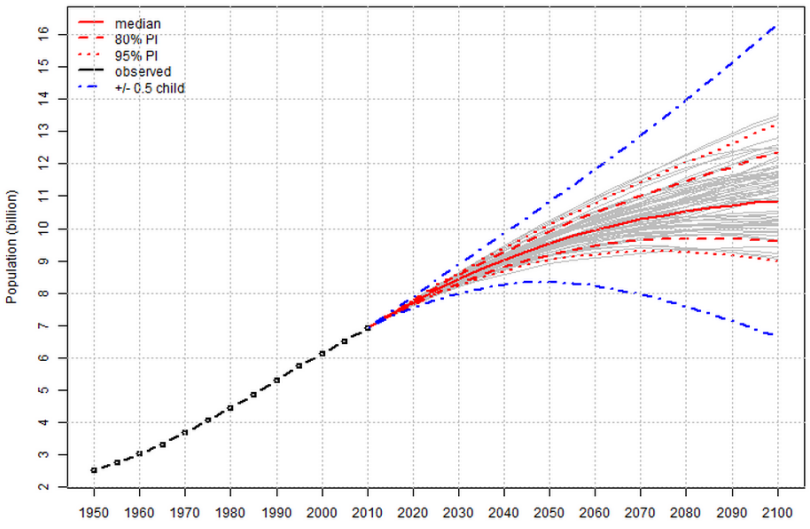


Fig. 1. Probabilistic projection of world population growth. Source: United Nations, 2014.

1.2 Developed countries ageing, developing countries becoming younger

The differences in population growth rate create considerable variation in demographical composition of the population of different countries. While there is a decrease in the number of younger people compared to that of elderly people and stabilization of the population number in the Northern more prosperous countries, one can see in the Southern countries an opposite demographic trend, with a large generation of younger people and still continuing growth of the population. Figure 2 illustrates the dynamics of the share of younger generations predicted till 2050.

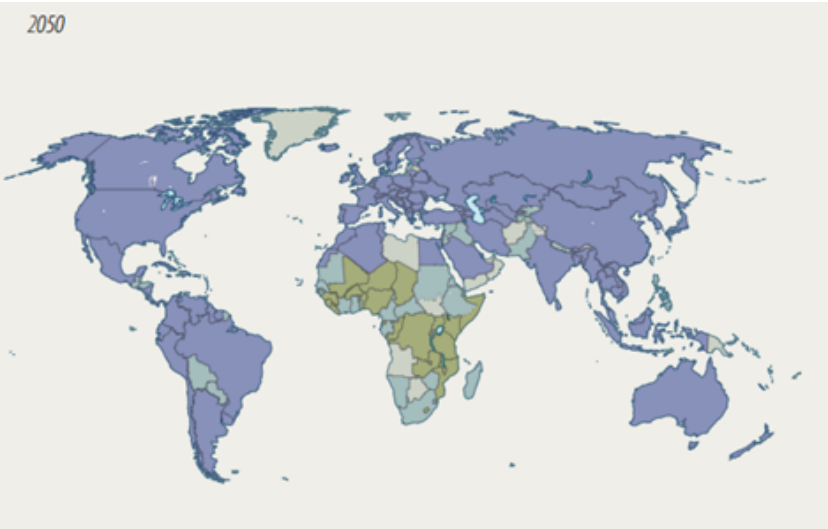
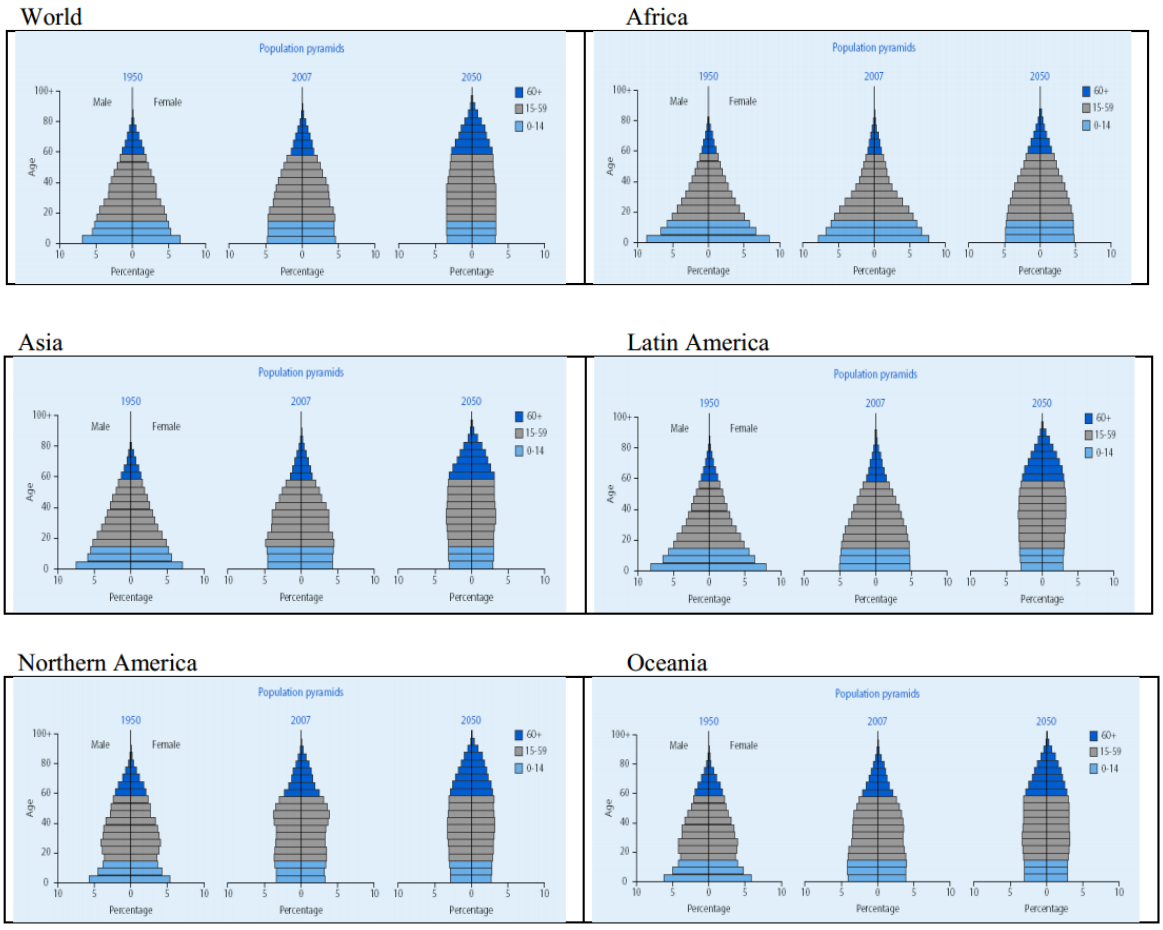


Fig. 2. The share of young people in the total population. Source: Human Development Report Office calculations based on Lutz and KC (2013). Cited from UNDP, 2014, p.62.

According to the European Commission foresight exercise "Europe in the World 2025", projections for Western-Europe, Asia and Africa show very different demographic trends for the decades to come (European Commission, 2009).



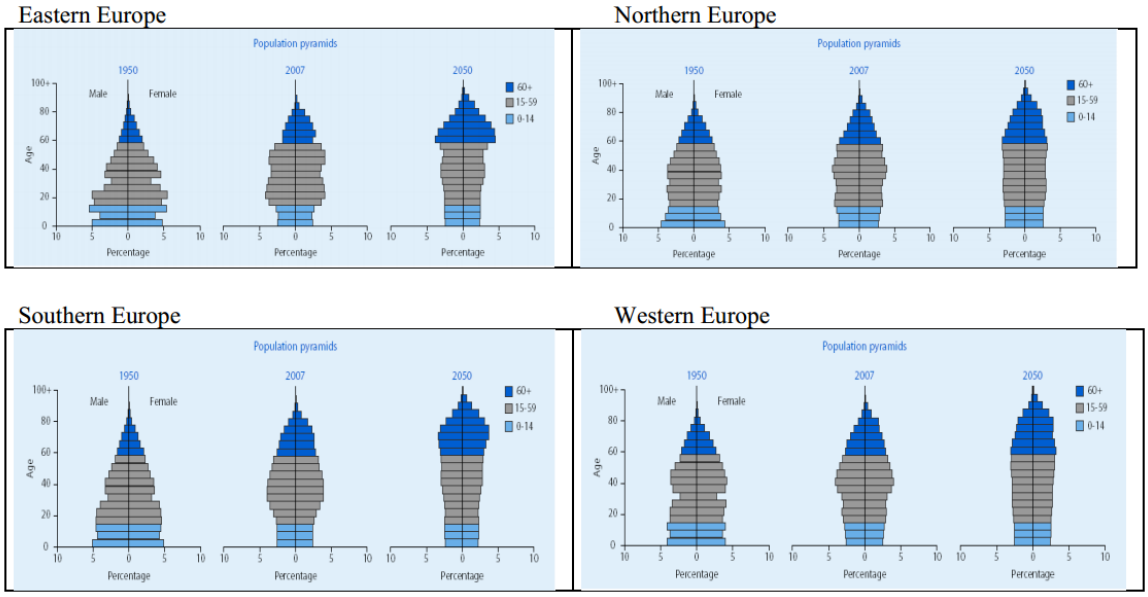


Fig. 3a-k. Population ageing 1950-2050. Source: United Nations, 2007. Cited from European Commission, 2009, p. 22.

1.3 Rising demand for higher education: regional differences

There is an increasing demand for and enrollment in higher (tertiary) education. In 2011, the average percentage of people entering higher education institutions worldwide exceeded 30% of the cohorts. In most developed countries (USA and Western Europe) the increase seems to slow down to reaching a saturation level of about 85-90% of the cohorts, while the fastest growing demand is observed in Central and East Asia (especially China), Latin America, Central and Eastern Europe. Africa and Arabic States still show slow increase in demand at a level of 2-10%.

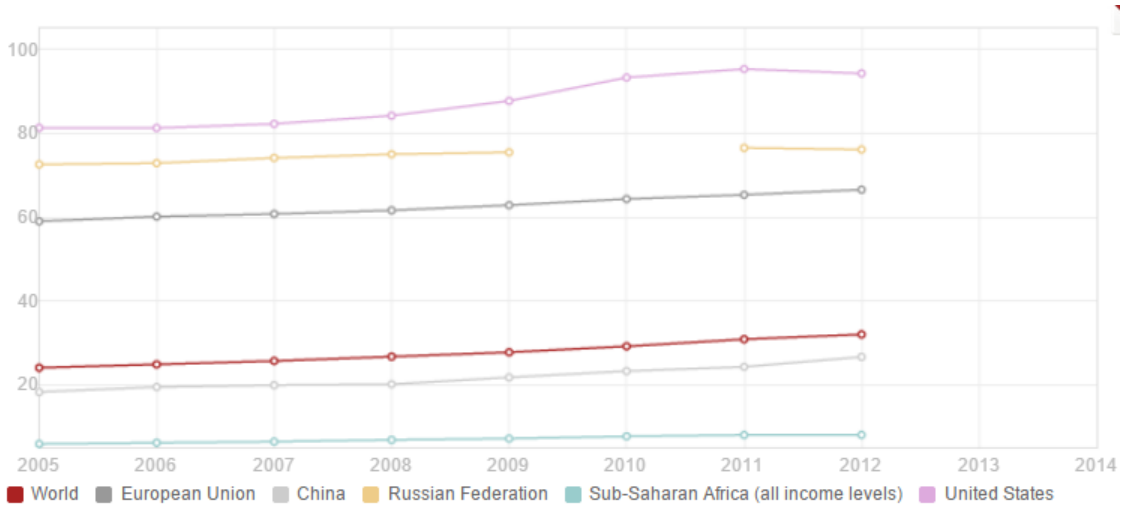


Fig.4 a. School enrollment, tertiary (% gross), global, in the European Union, China, Russian Federation, Sub0Saharan Africa, and the United States. Source: World Bank database.

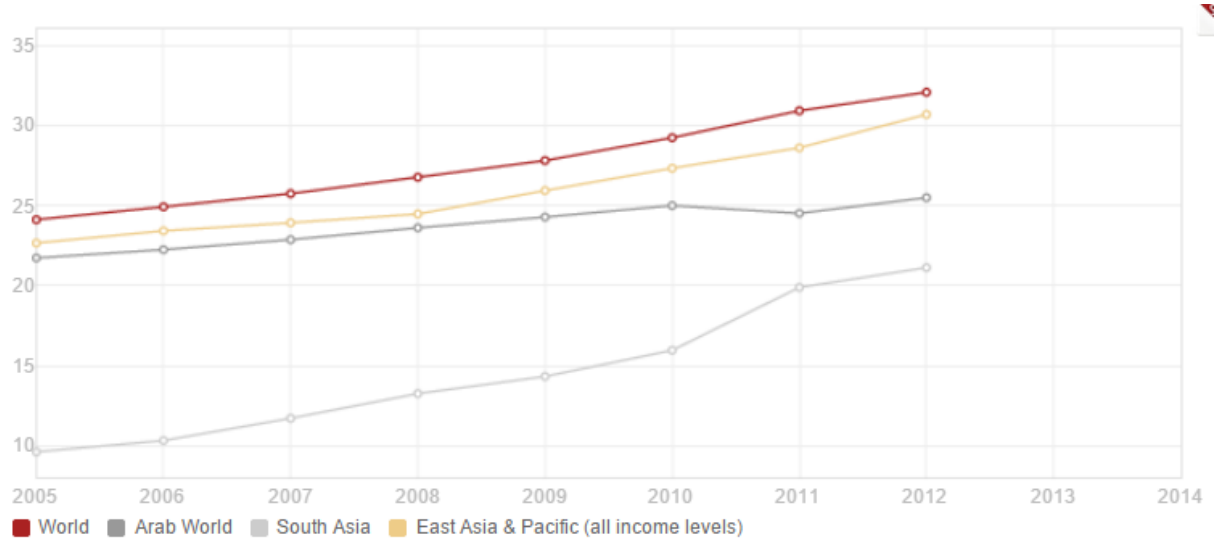


Fig.4b. School enrollment, tertiary (% gross), global, in the Arab world, South Asia, East Asia and the Paciific. Source: World Bank database.

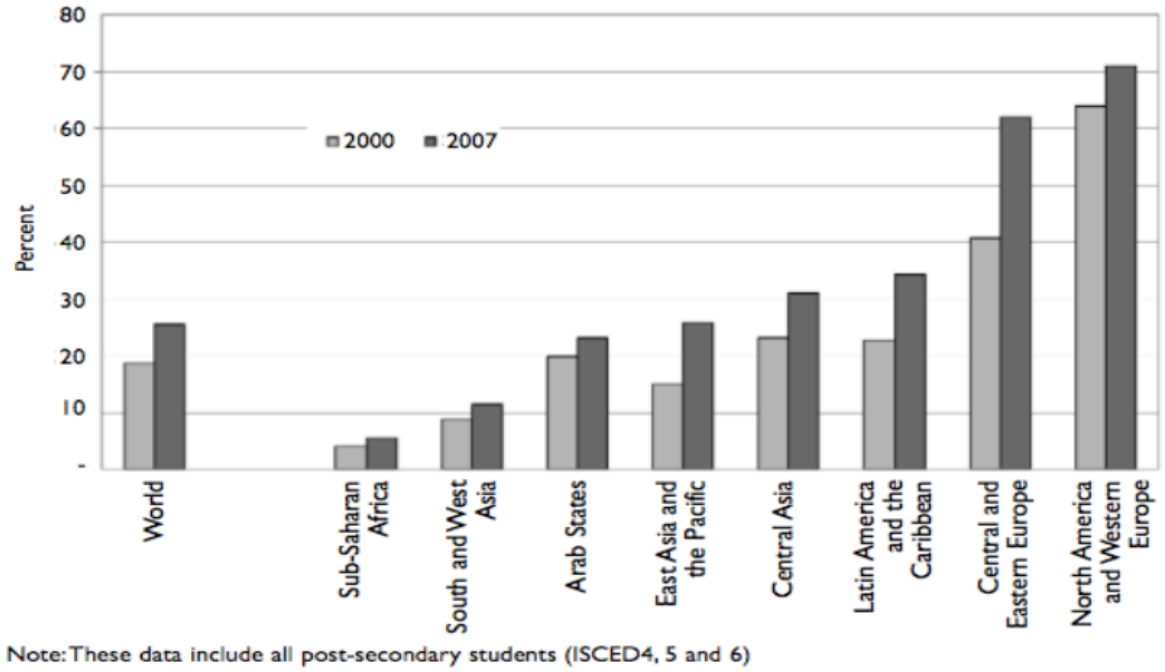


Fig. 5. Tertiary gross enrolment ratio by geographical region (2000 and 2007). Source: Altbach et al., 2009, p. v.

Retrospective analysis shows that such countries as Spain and Korea managed to increase tertiary enrollment from 20% to above 80% within a period of 30 years. If China and India, for example, will succeed to do the same, the number of higher education students in China could exceed that in the USA by a factor of 10. This expectation may be proved by the projection of the tertiary age population made by the British Council (2012). The introduction of MOOCs may considerably accelerate this process.

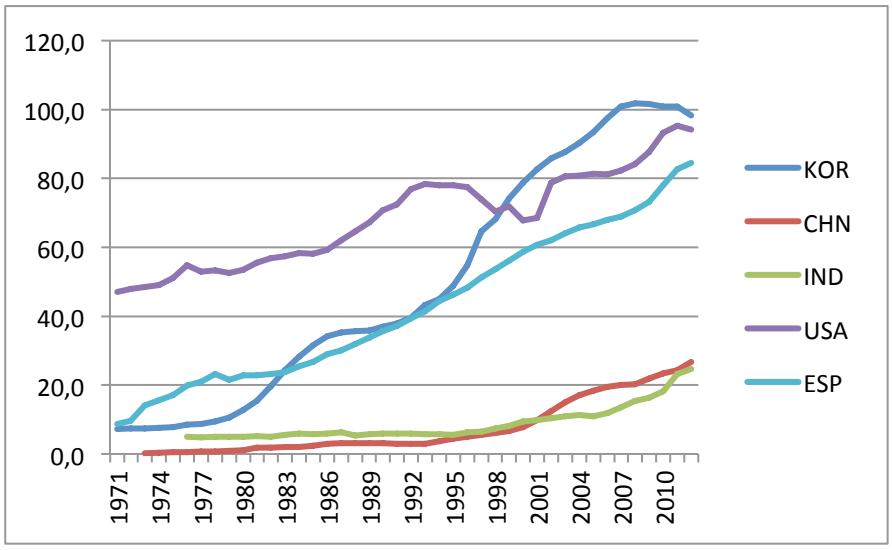


Fig. 6. Enrolment in tertiary education (1971 – 2010). Source: World Bank database.

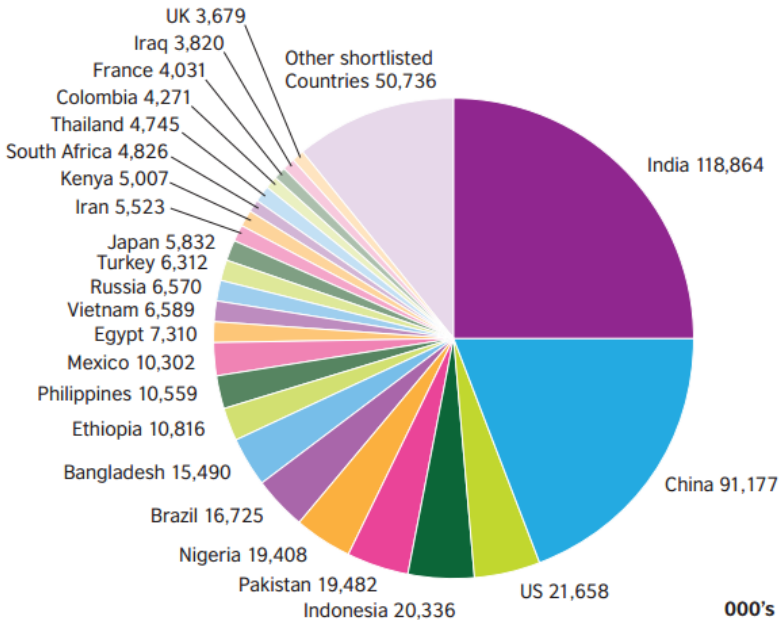


Fig. 7. Global tertiary age (18–22) population (2020). Source: UN Population Division, Oxford Economics. Cited from British Council, 2012, p. 33.

1.4 Intensification of international mobility of students

According to the report of the British Council (2012), the number of students enrolled outside their country of citizenship has risen dramatically. Over the past three decades the number increased from 0.8 million worldwide in 1975 to 4.3 million in 2011. This is more than a fivefold increase. Internationalization of tertiary education has accelerated during the past several decades, which reflects the globalization of economies and societies, and also the expansion of tertiary systems and institutions throughout the world (OECD Factbook, 2014). The mobility is mainly directed towards OECD countries.

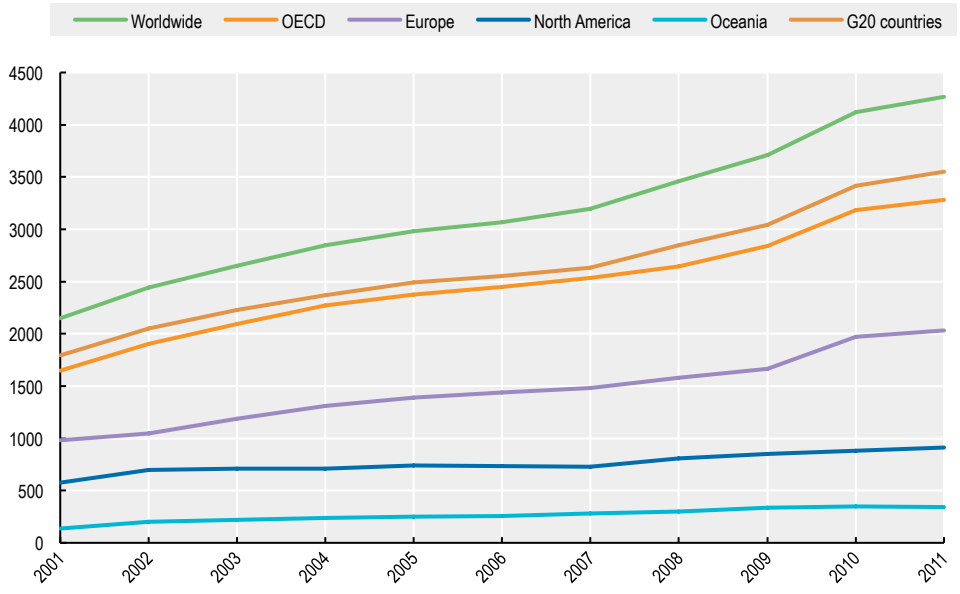


Figure 8. Evolution by destination in the number of students enrolled outside their country of citizenship Source: Statlink.

A majority of students comes from India and China and moves transcontinental to North America or Europe. This is partly connected with the growing demand for tertiary education in these countries that at present falls short in supply. According to Oxford Economics, the outbound mobility of student from India will still keep rising while it will stabilize for China, furthermore it is expected that mobility will concentrate more to neighboring countries.

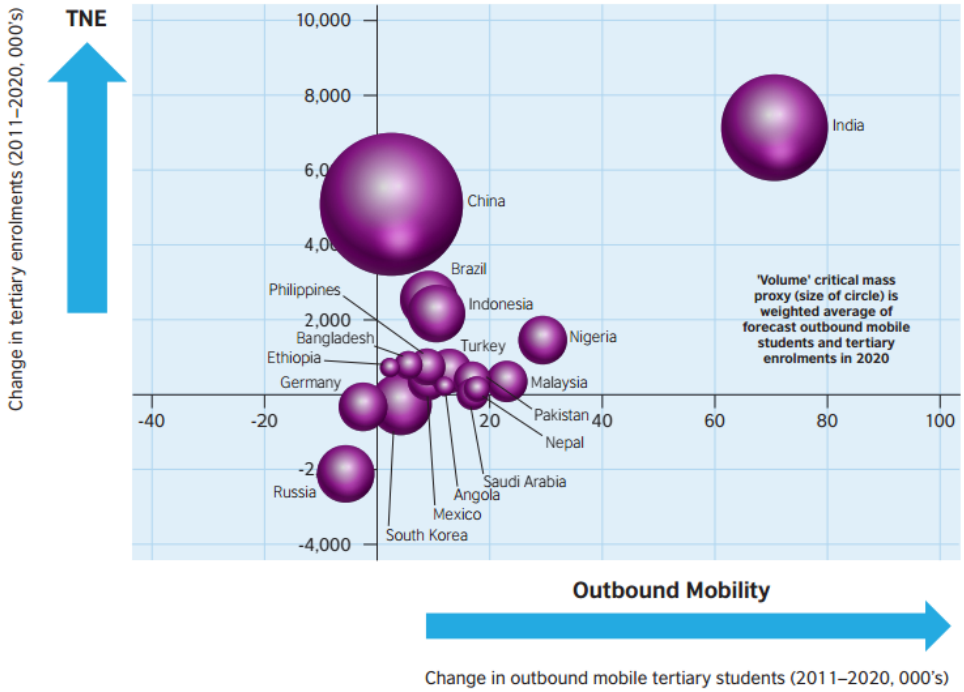


Fig. 9. Future higher education opportunities for global engagement – major countries (2020). Source: Oxford Economics. Cited from British Council, 2012, p. 8. See also: GlobalHigherEd, 2011, September 13).

1.5 Younger learn differently

Many authors (Levin, 2002; Wheeler, 2015; Prensky, 2001) emphasized the increasing gap between teachers (who learnt by reading books and listening to lectures) and students who are used to new media and get information not only from printed textbooks but also by the means provided through ICT and internet, which includes audiovisual stimuli, computer simulations, games and virtual augmented reality. Some authors use the term digital natives, which assumes that younger people have an inborn capability that is not typical of most elderly. (See also Steve Wheeler presentations.)

1.6 The new balance between leisure and work

During the last centuries the average number weekly working hours per worker have diminished (Huberman & Minns, 2007) mainly due to automation and changes of lifestyle. In general one can conclude that industrial societies use for leisure a part of the time they previously devoted to work. One can expect that this trend will continue and that new balances have to be found in the future society, including education (Entwistle, 2014, first edition 1970). A part of this new balance can be laying in ICT-enabled activities as learning for leisure and virtual reality.

Figure 10 shows the decrease in the number of working hours per week from 1870 to 2000 in Europe the US, Canada and Australia according to the data provided by Huberman and Minns (2007). The supposed starting points of the last two technology transitions described by Perez (2002) are indicated by red errors. The effect of automation – by division of manufacturing tasks – the one that started in 1913 is clearly visible in a reduction of working hours per week, while the effect of the start of the ICT age is less pronounced. This can be explained by the creation of work that is economically considered not essential but is meant to avoid unemployment. Graeber (2014), supposes even that the society has created stultifying "bullshit jobs" for mostly higher educated people for whom the economy no longer had much use, but who had their 38-hour contracts.

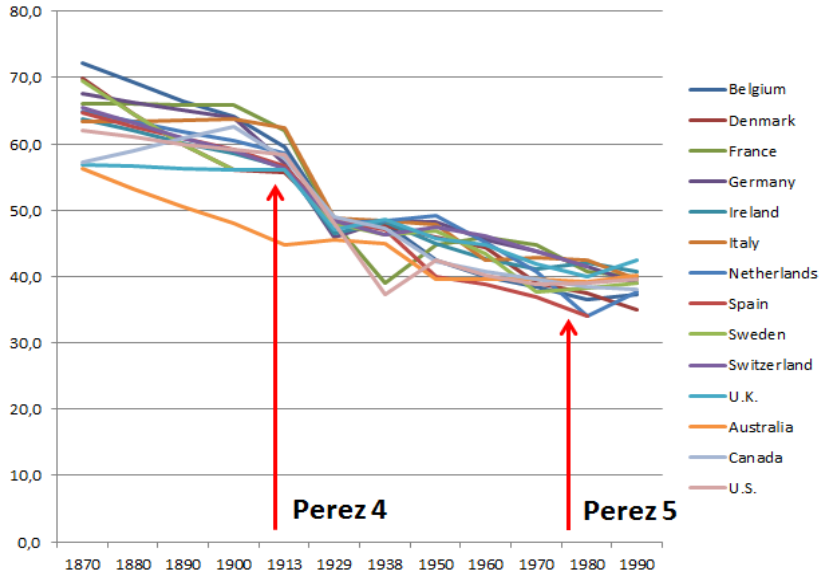


Fig. 10. Weekly labour hours, based on Huberman & Minns, 2007.

The fact that automation and ICT reduce the need for human work may force us to rethink not only the redistribution of work in our societies but also the issues related to education.

1.7 Long-distance interconnectivity and collaboration

Through ICT the interconnectivity between people around the world is dramatically growing not only in science but also in many other professions. People start to collaborate more and more in local and national but also world wide networks to exchange knowledge and experience and to do business – or socialize. Because of this work of future becomes more internationalized. This global "immediate" connectivity, pressures many businesses to increase their opening hours to stay directly interconnected with clients and suppliers worldwide (Mazmanian & Erickson, 2014)and/or to maximize their output and profit. Some authors predict that only a small elite will actually collaborate on long distance while others will stay only regional active – while others assume that the interconnectivity will transcend to almost every job (Cecchinato et al., 2015). ICT facilitated international collaboration needs attention in (higher education).

1.8 New balance of virtual and real life

People spent more time behind PCs and on IPads than watching television, which creates new health risks and has to be taken into account by educational institutions. Moreover it is clear that virtual life and real life get intertwined from childhood (Nunas et al., 2014), which creates both opportunities and risks. The establishment of a right balance is a part of ICT-related education. (See also 4.2 and 4.3).

1.9 Creating the personal "cloud"

The virtual presence of people in the cloud is connected to the virtual life, as if a kind of cv or portfolio is permanently online, which also suggests some risk for (future) privacy. Many people use such services as Facebook, LinkedIn, Ming, YouTube, where they are continuously presenting themselves and their products, which can be accessed by other users of the internet. A question connected to this is whether this transparent virtual presence can replace the paper cv and the formal documents as diplomas and, if so, how the construction of this "virtual" cloud-based images relate to (higher) education. Another aspect is that people create their own "rhizomic "mixed social learning (Wheeler, 2015) and working environment by connecting themselves to specific people, storage facilities, dropboxes, databases, apps and other cloud-based programs as well as such things as sensory networks and household devices. The successful development of this rhizomic environment and the way it is managed is an important target for (higher) education.

1.10 Machines as colleagues

The growing (learning) capacity of the internet and the increasing user friendliness of programs and equipment will gradually lead to socialization of ICT as a social entity rather than as a technical entity. The same may apply to robotics within a longer time interval.

2 Technological Trends

2.1 Fast unpredictable change of technologies

Technologies are developing faster and faster and offer more and more capabilities, which makes it hard to foresee what we should learn. Machines are taking over more and more skilled work but also of our cognitive processes. In addition, we see that the learning capacity of ICT and robots is increasing even with such a pace that computers and internet platforms may surpass our cognitive capabilities within many fields in the decades to come. Next to this we see an enormous improvement of interfaces, which allow for an increasing directness of human interaction with ICT and with internet. Kurzweil expects us even to develop immediate direct brain-to-computer and internet interfaces within the first half of this century. This would allow us direct immediate access to the information and knowledge on the web. Finally we see a fast development in speech and face recognition and translation of languages, which on the long run will have a great influence not only on how we learn but also on what we should learn.

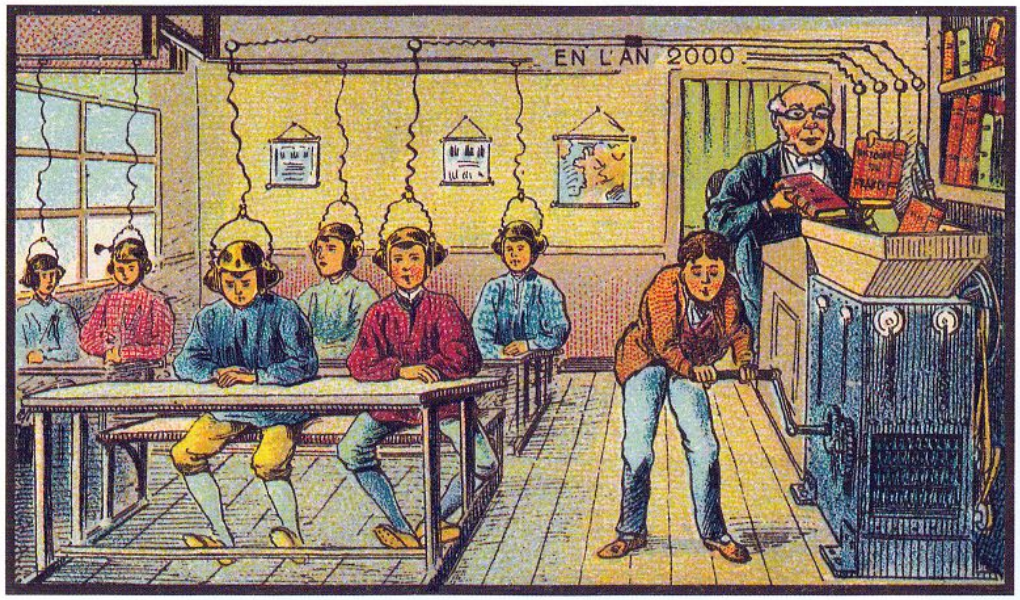


Fig. 11. Postcard “At school” (1900). Vision of school at 2000. Source: The Public Domain Review.

The idea of direct brain machine interaction is not new (Fig. 11). We may hope that the brain will stay in the lead and that we will not end up in the mode of education predicted in the postcard.

2.2 Increased access to internet worldwide but digital divide remains

The number of internet users has increased enormously in the high-income countries, it is also growing in the rest of the world, the dominating way of internet access is through mobile connections. Future growth of the internet access is expected to depend on the expansion of mobile technologies and broadband rather than on fixed connections. According to ITU, 44% of households have Internet access at home, but in Africa only one out of ten households is connected.

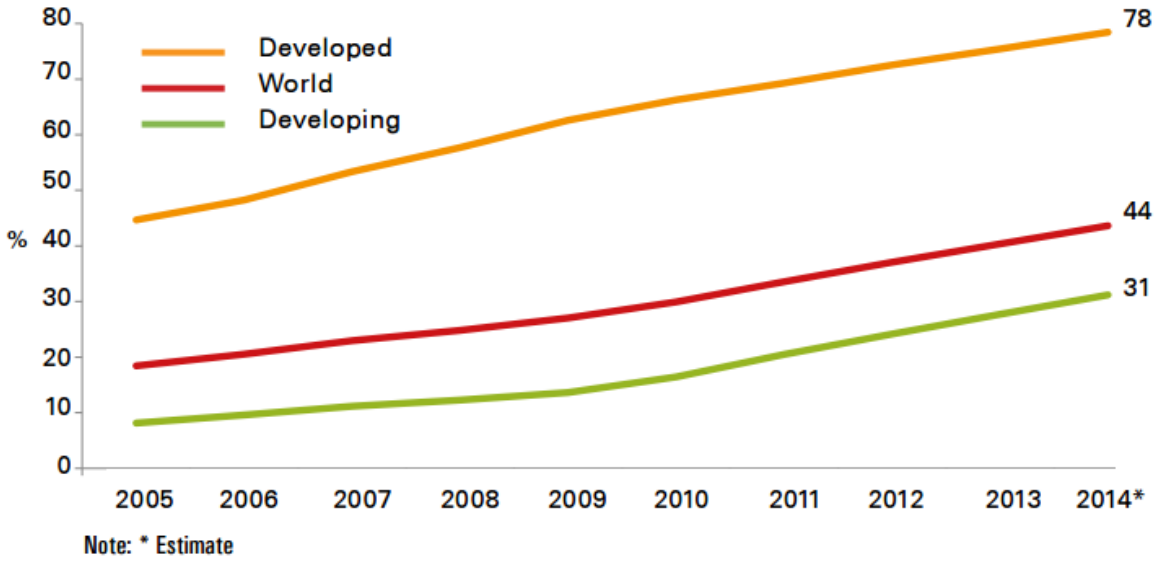


Fig. 12. Percentage of households with Internet access, by level of development, 2005-2014 (*). Source: ITU World Telecommunications Indicators database. Cited from: ITU, 2014, p. 6.

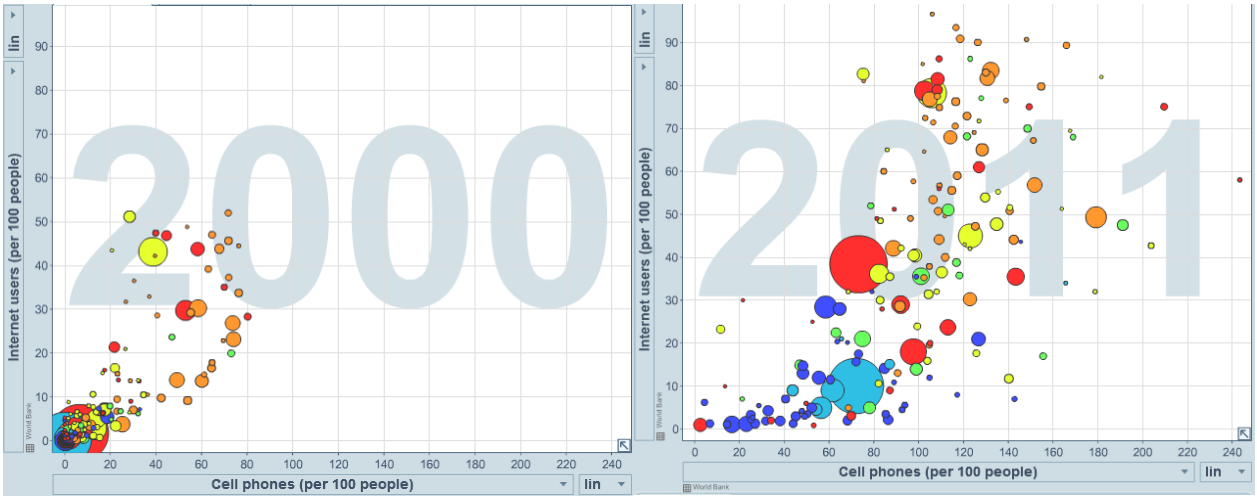


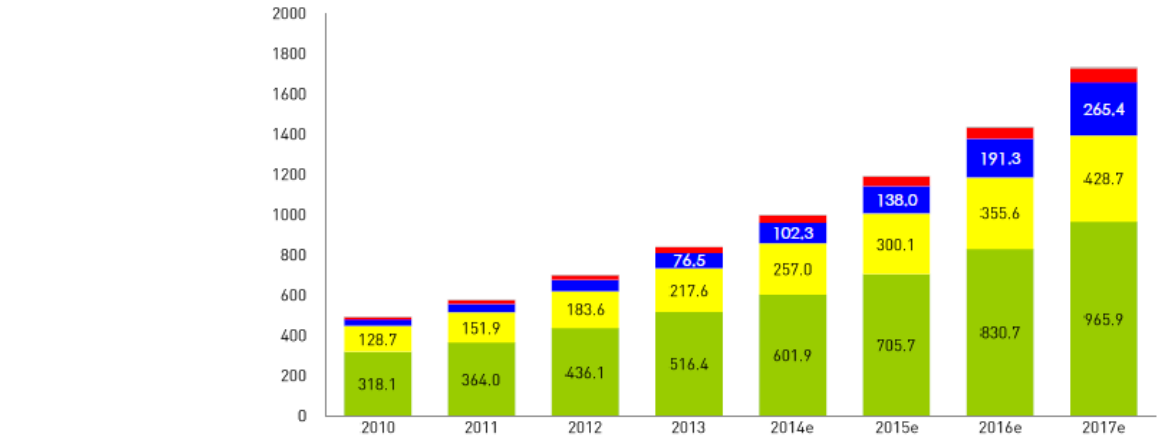
Fig. 13 a-b. Gapminder visualisation of the number of internet users (vertical axis) and mobile users (horizontal axis) in different countries of the world in 2000 and 2011 (the dynamics can be seen in the video). The dynamics is visualized in the **video** (push 'play'). Each circle represents a country, the size represent the size of the population of users: yellow - North and South America, red - East Asia and Pacific, Orange – Europe and Central Asia, light blue – South Asia, green –North Africa and Middle East, dark blue – Sub Saharan Africa (World Bank data).

Remarkable is the development of China (the largest red circle) and that of India (largest blue circle), which both have a similar level of mobile penetration, but very different use of the internet.

2.3 Increased role of open distance learning in fast growing economies and less densely populated areas

The UNESCO IITE brief "Technologies in Higher Education: Mapping the Terrain" (UNESCO IITE, 2015) and the UNESCO policy brief "Introduction to MOOCs: Avalanche, Illusion or Augmentation?" point to the fact that ICT is used in open learning "*to provide formal education for learners who are separated from their educators and other learners in time and place. The value of open learning that uses ICT is its potential for scale (its ability to handle very large numbers of students) and reach (its ability to provide access to education at any place at any time).*" In addition, it states that under certain strict conditions (regarding design, infrastructure, teacher quality and finance) ICT-based open learning may have a good quality outcome with a better cost benefits ratio than campus-based learning, which especially applies to the cases, when large student populations are spread over a large territory. Online education is therefore on the rise in many developing countries, where there is a large demand for higher education. UNESCO IITE recently made updates of this developments in China (Wang & Zhao, 2011), Brazil (Inamorato dos Santos, 2011) and the Russian Federation (Sigalov & Skuratov, 2012).

According to the iResearch report on China online learning (iResearch, 2014), there is a huge and growing demand for higher online learning (see Figs. 14-15), especially in vocational training for such subjects as IT, finance and management. Next to this there are large segments for teacher and language training.



	2010	2011	2012	2013	2014e	2015e	2016e	2017e
Online pre-school education	0.8	1.0	1.3	1.8	2.2	2.9	3.8	4.9
Enterprise e-learning	12.4	17.0	22.9	27.5	34.6	45.0	55.8	69.0
Online primary and secondary education	31.0	41.1	56.6	76.5	102.3	138.0	191.3	265.4
Online vocational education	128.7	151.9	183.6	217.6	257.0	300.1	355.6	428.7
Online higher academic education	318.1	364.0	436.1	516.4	601.9	705.7	830.7	965.9

Source: The data is based on the financial results published by enterprises, data released by bureau of statistics, interviews with experts and iResearch statistical model.

Fig. 14. Higher education made up the largest share in revenue. Structure of China Online Education Revenue in 2010-2017. Source: iResearch, 2014, p. 11.

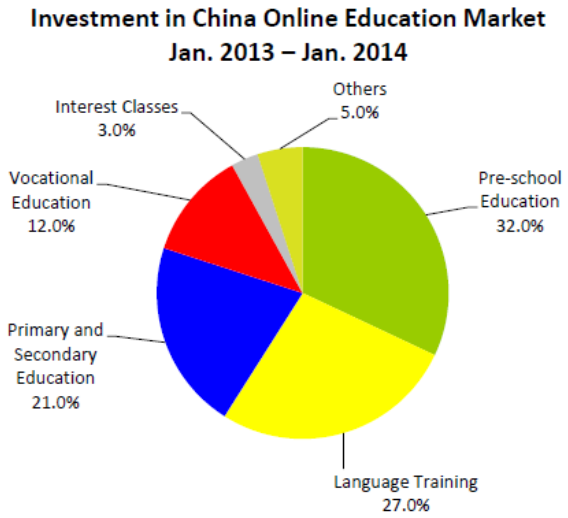


Fig.15. Share of Different Online Courses in 2013. Source: iResearch, 2014, p. 8.

The UNESCO report "Renewing the Knowledge Societies Vision for Peace and Sustainable Development" (UNESCO, 2013) also emphasizes that: *Distance education is frequently identified as the miracle solution to the lack of educational materials and human resources, including the capabilities for learning such as reflection and making sense of information*." Moreover, "*It can serve as an effective means of giving better access to scarce learning resources.*" It concludes that "*to be effective, distance education must be designed well in advance, rely on high quality content, and qualified technicians, teachers and tutors, and build the capabilities associated with a range of literacies among its learners."*

2.4 Massive Open Online Course (MOOCs) increasing in numbers

The UNESCO IITE brief "Technologies in Higher Education: Mapping the Terrain" and UNESCO IITE policy brief "Introduction to MOOCs: Avalanche, Illusion or Augmentation?" (UNESCO IITE, 2013; UNESCO IITE, 2015) reflect on the development of MOOCs. They define the MOOC as *"a model of educational delivery that is, to varying degrees: massive, with theoretically no limit to enrolment; open, allowing anyone to participate, usually at no cost; online, with learning activities typically taking place over the web; and a course, structured around a set of learning goals in a defined area of study"*. The report further points to the fact that *"Definitions of MOOCs tend to emphasize openness in relation to the ability of learners to be able to access content through web based platforms, openness in terms of cost, openness in terms of the use of open courseware, or openness with respect to learner collaboration.*"

The briefs distinguish between two distinct types of MOOCs "*when compared in terms of their underpinning theory, format and structure, namely cMOOCs (or connectivist MOOCs) and xMOOCs (the 'x' is adapted from MITx and edX). Whilst the two types of courses have some common features, they clearly differ with regards to their learning theory and pedagogical model — in particular, the different way in which social interactions happen during the courses. The concept of openness in cMOOCs and xMOOCs also has different meanings, with learner autonomy, peer-to-peer learning and social networking being emphasized in cMOOCs, whilst xMOOCs are based on a tutor-centric model that establishes a one-to-many relationship to reach massive numbers*."

Many sources and authors agree on the fact that MOOCs make a sudden rise in numbers and attract an enormous worldwide population of online learners. Although many of these learners seem not to complete whole courses it is clear that still an enormous growing amount of learning (or knowledge transfer) takes place. Also in India there is a clear growing interest for the introduction of MOOCs in formal as well as in informal learning (FICCI, 2014).

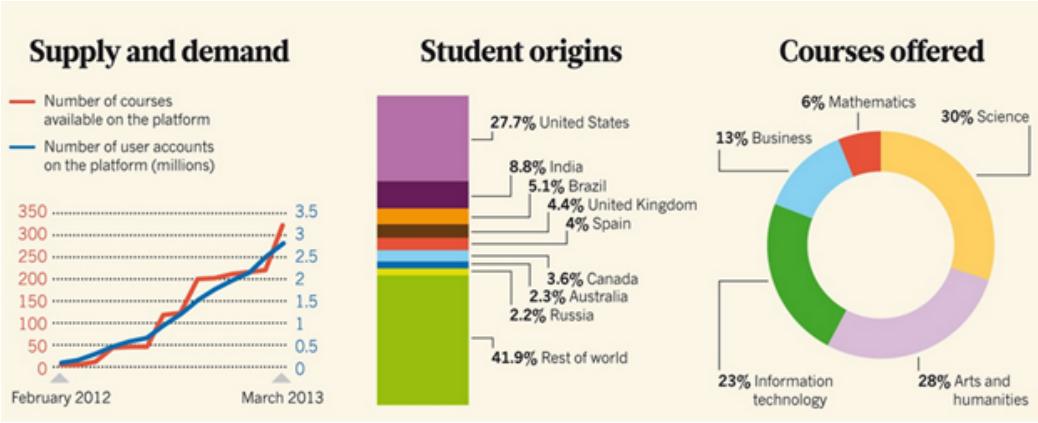


Fig. 16. MOOCs Rising. Over more that little year, Coursera in Mountain View, California – the largest of three companies developing and hosting massive open online courses (MOOC) – has introduced 328 different courses from 62universities in 17 countries (left). The platform's 2,9 million registered users come from 220 countries (centre). And courses span subjects as diverse as pre-calculus, engine nutrition, and introductory jazz improvisation (right). Cited from Waldrop (2013).

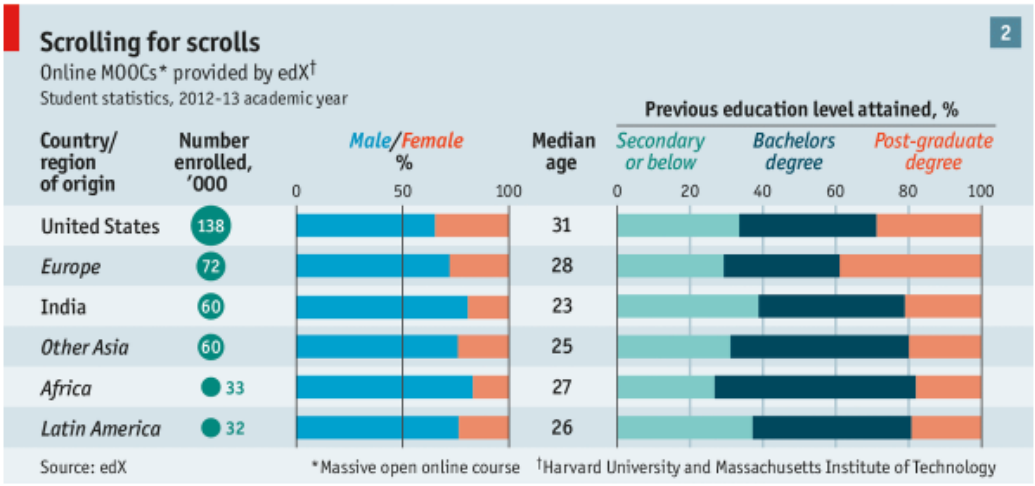


Fig. 17. Scrolling for Scrolls. Source: EdX. Cited from The Economist, 2014.

2.5 The law of Moore

According to an article in Time (Peckham, 2012), Michio Kaku suggests that Moore's Law – that predicts that the number of transistors that can be fit on a computer chip will double every two years, resulting in periodic increases in computing power and memories - will run to its end around 2022. Till now this law has been in force (because the chip industry used this to target its progress), but it is clear that silicon technology will be stretched to it ultimate border around 2022.

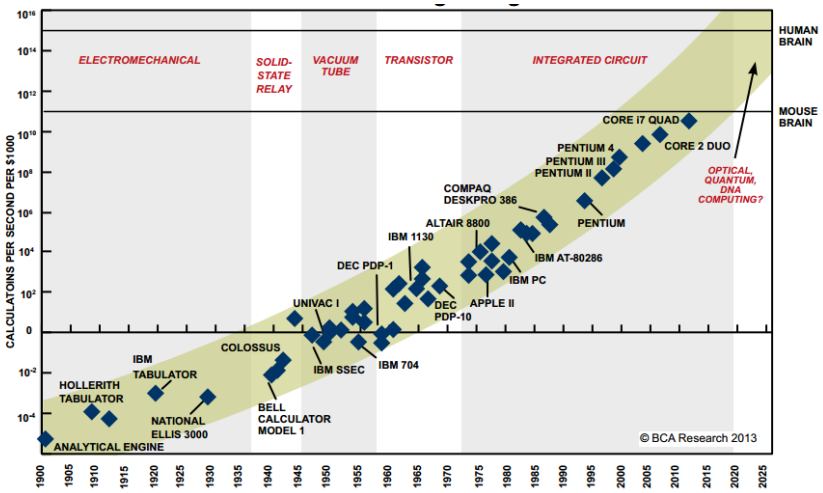


Fig. 18. Moore's Law: Over 100 Years and Going Strong. Source: Kurzweil, R. (2005). The Singularity is Near: When Humans Transcend Biology, p. 67.

As the number of transistors on the chip exponentially increases the price decreases in a similar way, which meant that computer with very higher capacity became available to everyone in the developed world and make their way to the rest of the world still with increasing capacity for storage of data and speed of computing and communicating.

2.6 Big data and the cloud: online tools and stimuli to handle, analyze, synthesize, transform, visualize and transfer exponentially increasing and diversifying data

Development of ICT created the opportunity to store more and more data and to analyze them in smart ways by tools that are provided in the cloud. Since 2002 the amount of digitally stored data has surpasses the total amount of data that has been stored in a similar way throughout human history in the form of photos, films, gramophone records, tapes and by (type) writing on paper. During the two years before 2013 the volume of available data increased tenfold towards the amount of data from all human data collection before in history.

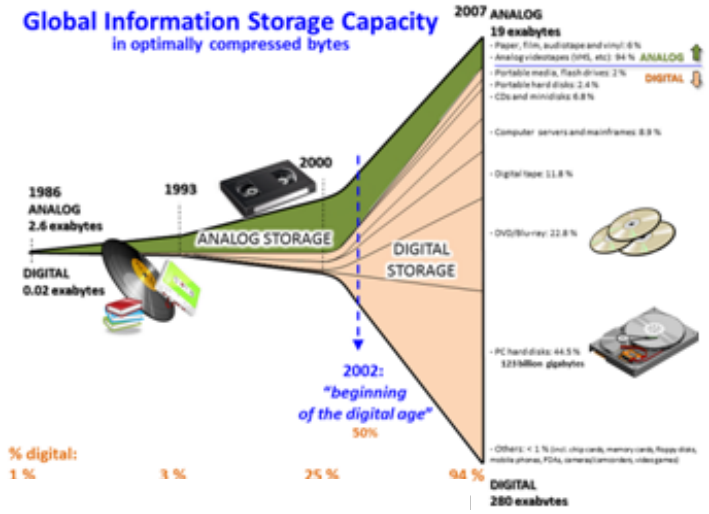


Fig. 19. Global Information Storage Capacity. Source: Hilbert & Lopez, 2011.

The automation of science contributes further to the enormous data increase by delivering more and more data coming from such devices as Mars landers, satellites, DNA sequencers, NMR scans, large physics measurement devices as the LHC, networks of climatological, seismological, chemical and other sensors in the fields and seas, as well as from RFID's and other tracking systems that follow our movements and action. This growing amount of data creates amazing possibilities for research but needs a rather different approach than before. The focus from analyzing just a fragment of a genome by patient sequencing this fragment now alters to the comparison of many automatically performed sequences of whole genomes of different individuals and species. The study of one astronomical object in the sky now leads to a quick reconnaissance in databases of past astronomical scans to search for comparable objects and so further. It is clear that this necessitates curricular changes towards procedures handling big data versus producing the data.

According to an article in the Nature News blog (van Noorden, 2014), the global scientific output evolves exponentially. The increase of people with higher education degrees around the world, as well as the increase of the total money spent on research worldwide and the automation of many "scientific observations" justifies the expectation that this productivity will enormously increase even above the present growth level.

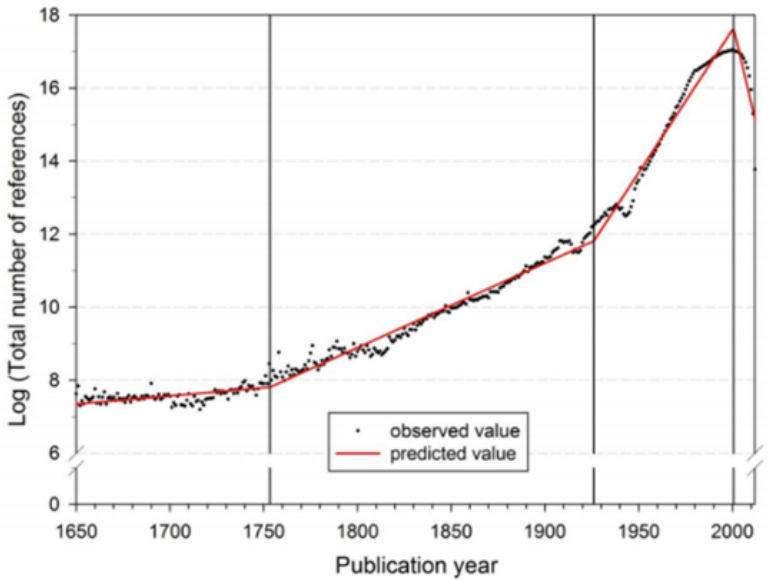


Fig. 20. Annual increase of scientific references. Source: Bornmann und Mutz 2014, arXiv:1402.4578. Cited from Anderl (2014).

2.7 Visualization, augmented reality, simulation and gamification

It is clear that ICT enabled simulation and visualization as well as augmented reality offer many opportunities to learn more efficiently. This applies to vocational learning as well as to academic learning (Wu et al. 2013). The same applies to gaming which also has a strong motivational value (Shorrer, 2014). Simulations and visualization techniques are moreover essential to report data analysis in a comprehensible and attractive way. This means that the designing and development of simulations as well as the use of visualization techniques should be seen as part of the 12st century skills.

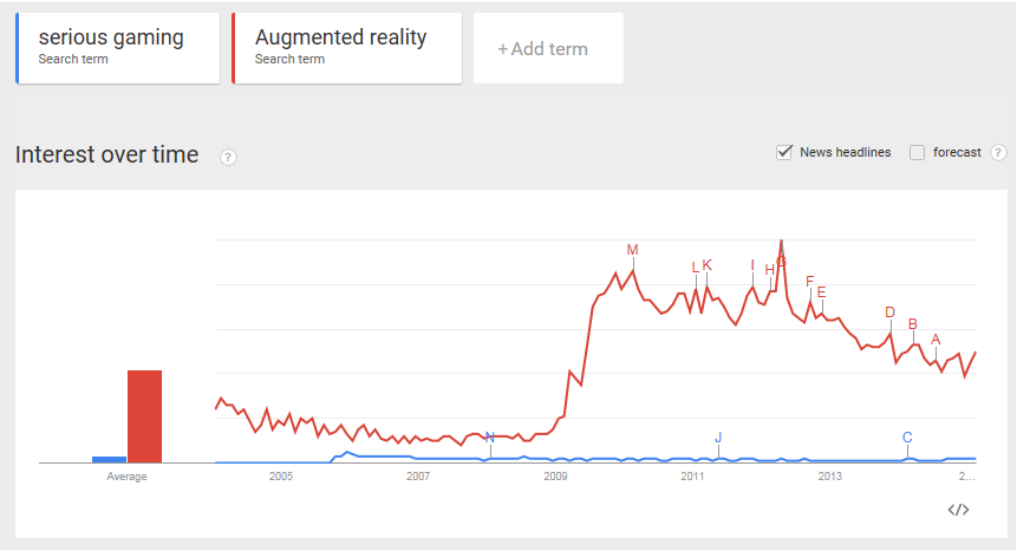


Fig.21. Google trends of the use of the search terms 'Serious gaming' and 'Augmented reality' shows that the latter seems to be more known to a wider audience (trends search run 27 February 2015)

2.8 Cognitive enhancement 4.0: fusing humans and machines

Kurzweil assumes that interfaces between humans and computers will become closer and closer and may even lead to merging. Although it is a long way from Google glasses to an implanted artificial retina with full or even enhanced recovery of sight, science and technology make the first steps into this direction. This line of research was propagated by Vidal (1973) and has lead to a series of approaches to bring machines and humans in closer interaction. An overview of this field was given by Danilov & Tyler in 2005 (Danilov, 2011).

2.9 The Internet of Things

The Internet of Things is a concept that describes the evolution of the future internet that connects not only people but also sensory input systems (including RFID readers and machines that can perform tasks (like printers, robots, vehicles).

This evolution is still going on and is critically followed and guided by the Council which is a group of experts distributed all over the world. The Council stated: "*imagine a world where everything can be both analogue and digitally approached – reformulates our relationship with objects – things – as well as the objects themselves. Any object that carries an RFID tag relates not only to you, but also through being read by a RFID reader nearby, to other objects, relations or values in a database. In this world, you are no longer alone, anywhere. It holds dangers, but it also holds promises*"

In daily practice the Internet of Things may mean avoidance of traffic jams by direct computer-assisted guidance of central computers that track all traffic and the navigators that send their "requested routes" and that get feedback from the central computer to adjust their route to less crowded routes. In business it may mean a lot more for logistics, manufacturing, agriculture, and marketing. For science it may mean the possibility to track many environmental sensor signals on real time but also social processes. CISCO website states "*The Internet of Things (IoT) is increasing the connectedness of people*

and things on a scale that once was unimaginable. Connected devices outnumber the world's population by 1.5 to 1. The pace of IoT market adoption is accelerating because of:

•Growth in analytics and cloud computing

•Increasing interconnectivity of machines and personal smart devices

•The proliferation of applications connecting supply chains, partners, and customers"

CISCO outlines the opportunities that "*far outweigh the challenges, if managed with the right partner. The connection of devices, machines, and things allows you to dynamically generate, analyze, and communicate intelligence data, increase operational efficiencies, and power new and greatly improved business models*.

http://www.oreilly.com/data/free/files/data-emerging-trends-and-technologies.pdf

2.10 The cloud as a source of new capabilities

The cloud is closely related with the internet of things as one of its enablers but also has its own position by storing our data that can be accessed anywhere and anytime as well as by providing apps and programs anywhere anytime to users

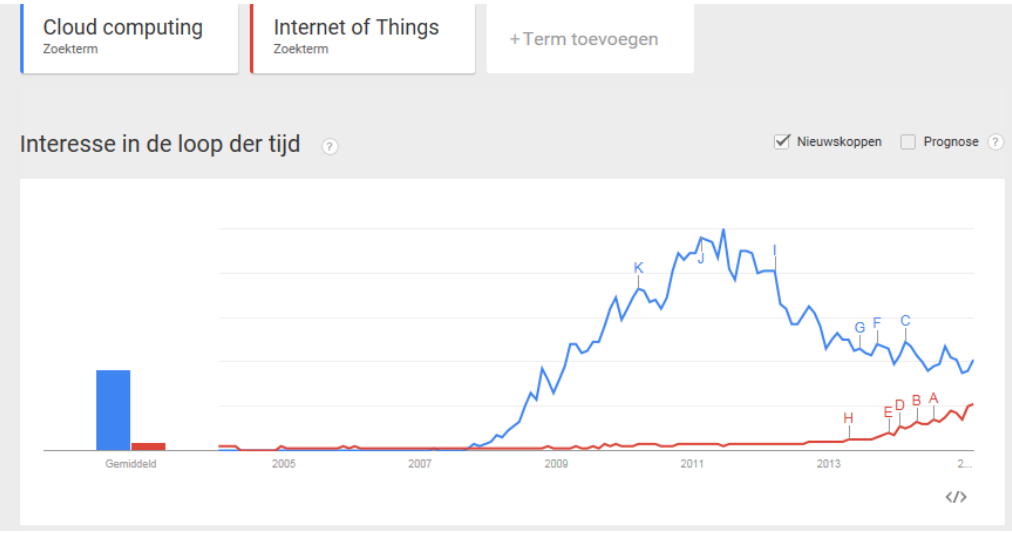


Fig. 22. Google trends of the use of the search terms 'cloud computing' and 'Internet of Things'

3 Economic Trends

3.1 The increasing capital misbalance in the world

Piketty (2014) and other authors emphasize that capital is accumulating within a small group of people and that reinvestments of this group mainly focus on the profit from reduction of labor need for production and services.

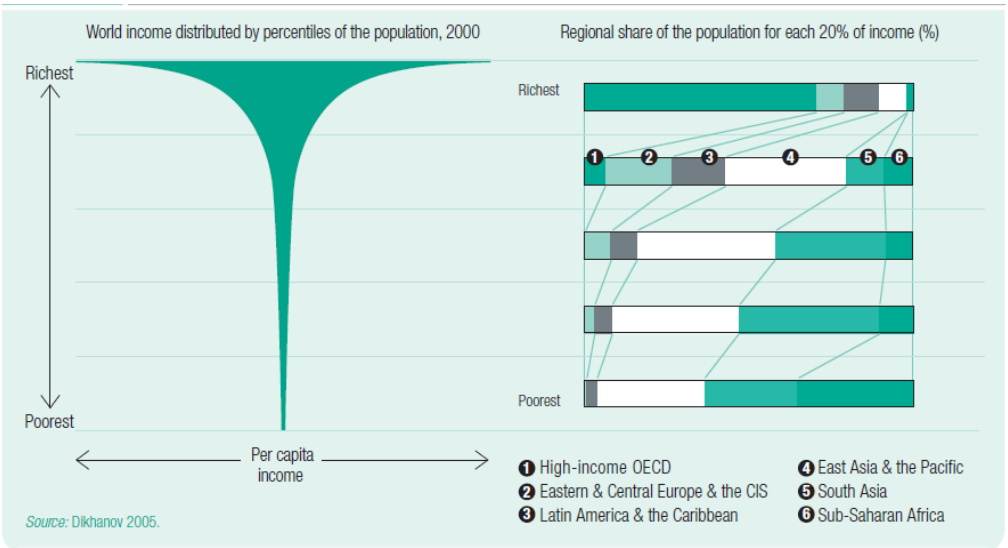


Fig. 23. World income distribution and regional share of population for 20% of income. Source: UNDP, 2005, p. 37.

3.2 Youth unemployment on the rise, including young adults with higher education degrees

Recent employments prognoses performed by the International Labour Organization show an increase in youth unemployment worldwide.

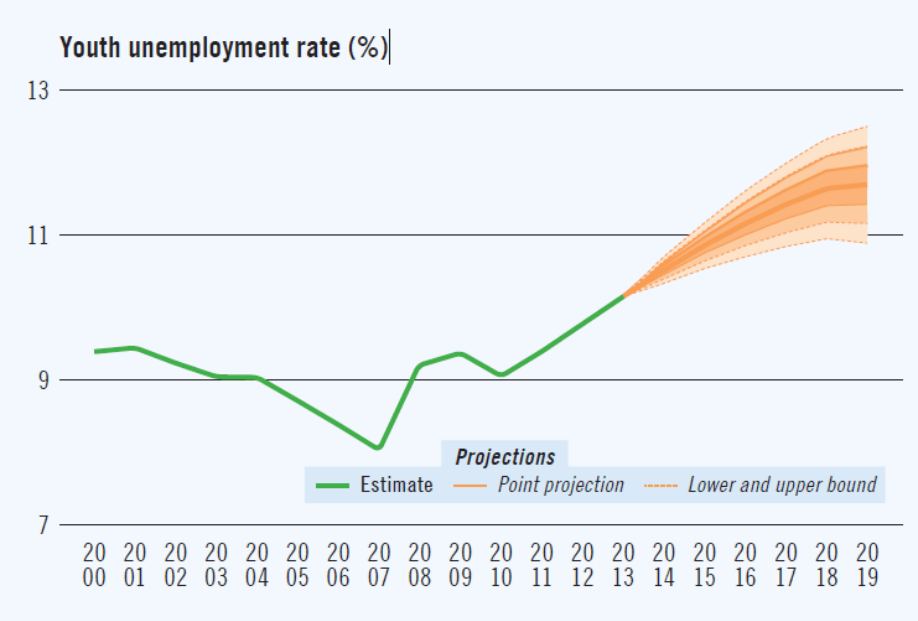


Fig. 24. Projections for youth unemployment. Source:ILO database.

This employment trend also concerns the higher educated part of the younger generations in many countries, including the European Union.

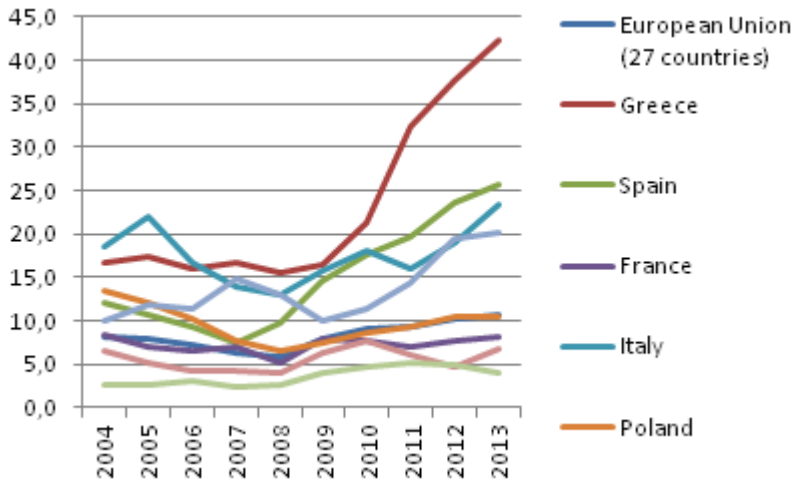


Fig. 25. Statistics of unemployment of 25-29 year old with tertiary education degrees in several European countries (percentage of age groups). Source: Eurostat database.

3.3 New HE providers offering sharp prices, or for free

Digitalization opens the opportunity for new players in the higher educational field, especially for long distance learning.

3.4 New business models for HE providers

MOOCs and open distance learning force the existing HE providers to rethink their business models. The appearance of free courses that can be accessed by students from any country of the world creates challenges for courses that are delivered on fee basis and force institutions to rethink their business models.

3.5 New specializations and new alliances of HE players

Globalization and ICT (see in particular 3.3 and 3.4) force and enable higher education institutions to redefine themselves.

3.6 Increasing future need for high-level ICT skills for knowledge work

The new opportunities given by automation and ICT require a Higher Educated working force hat can deal with these new opportunities to resolve the societal challenges of the future and to create new economic activities.

3.7 The decline of the "knowledge economy" as a utopian future

Current trends suggest that the world of work is likely to become increasingly polarized as a result of the intersection of demographic and technological trends over the coming two decades. Highly competitive R&D activities and knowledge work will continue to be needed, but the capacity for digital technologies to enable businesses to "offshore" all forms of work to the lowest cost environment, to produce many products and services at ever decreasing cost and by ever fewer people, and to standardize and manage diverse workforces, leads to the suggestion that highly rewarded, creative and autonomous work is

likely to be restricted over the coming two decades to ever smaller global elites. In contrast, ageing populations and the rise in demand for individuals to play multiple working, caring and learning roles, are likely to see a rise in demand for caring, face to face and personal services roles, often the roles, which are poorly rewarded and valued. These developments may bring an end to current hopes of a "democratic knowledge economy" and hasten the search either for changed social values to mitigate the potential inequalities of a polarized workforce, or for new sites of investment and development (such as in the environmental or "virtual world' sectors).

3.8 Privatization: increased private share of costs

Many authors but also the OECD plea for an increase of the private funding of higher education, due to the fact that the costs cannot or should not be borne by the society. This trend now becomes the reality in some countries. Justification of this policy is the supposed future return of profit in higher salaries and better job opportunities.

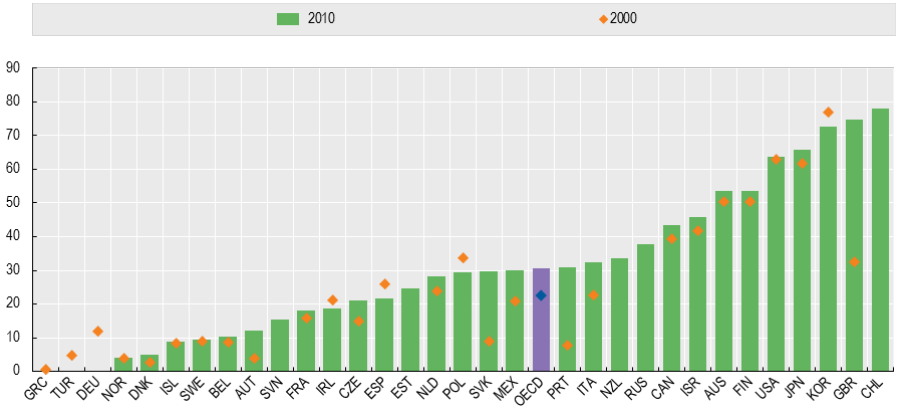
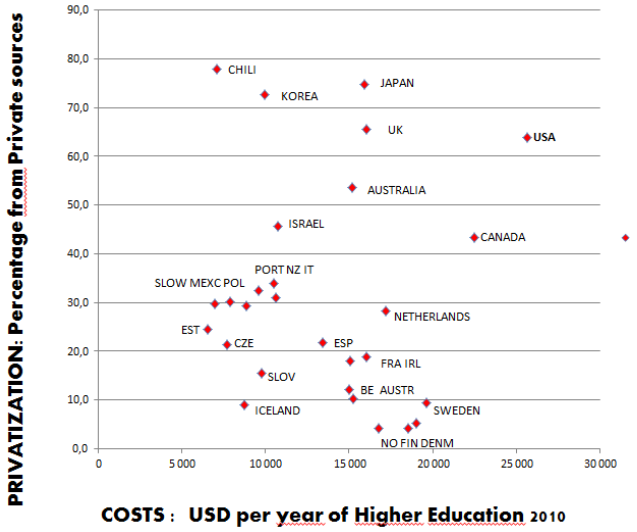


Fig. 26. Share of private expenditures in higher education in 2000 and 2010. Source: OECD (2014a), p. 201.

Fig. 26 shows a small increase in the relative share paid by private sources (usually student fees), on the average the share has increased for OECD countries from 22 to 30%. Further analysis of these data shows that privatization is not directly connected to exceeding public costs of higher education, but rather with local political preferences or culture, which can be seen best in the segment of countries where 15 000 to 20 000 USD per student is spent, see Fig. 27.

Fig. 27. Analysis of OECD data



3.9 Rising costs of higher education

According to the OECD Factbook 2014, over the same period (2000 to 2010) the average price per student year in OECD countries increased from 9,086 USD to 13,528 USD per year, which means an increase of almost 50% over 10 years.

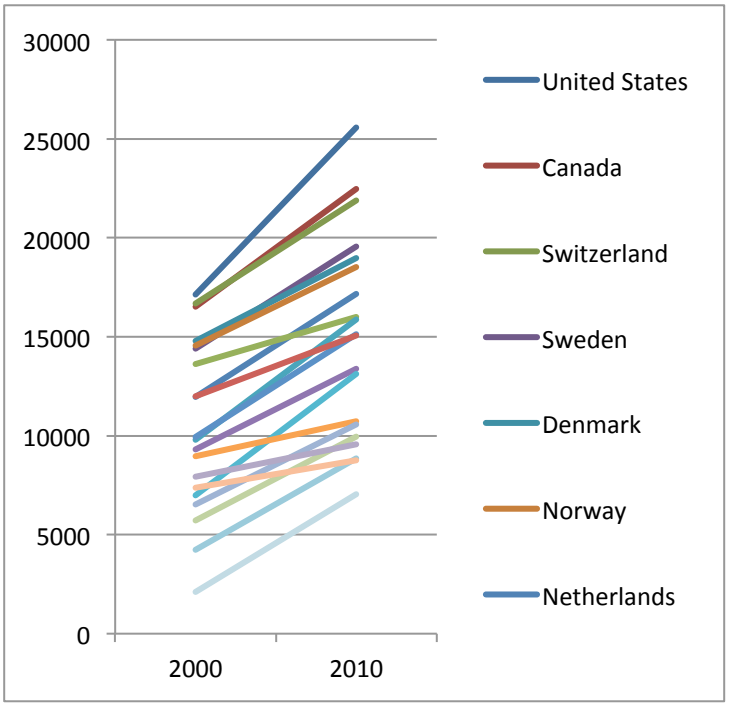


Fig.28. Rise of yearly costs per tertiary student over a period of 10 years, based on OECD Factbook, 2014.

3.10 Decreasing delivery costs in education

Many sources confirm that ICT (can) bring efficiency gains in the organization of education, as well as in the activity of teaching. This would mean that the actual "production" costs of higher education will decrease (Ruth, 2012; Deming, 2015). This decrease manifests itself in MOOCs and other open courseware that are offered for free.

3.11 Decrease of production costs for data, data processing, analysis and synthesis

The same applies to the gathering and analyzing of data, which is one of the core businesses of researchers and other higher education degree professionals (Evans, 2010).

4 Environmental Trends

4.1 Grand global and local challenges that require intelligent answers

The world encounters many grand challenges, such as the combat against poverty, the improvement of health in the underdeveloped countries, combating diseases and natural disasters but also the issues related to the provision of food, energy, (clean) water and scarce resources for growing populations with increasing demands for their quality of life.

The climate change is tightly connected to many of these challenges and limits the scope of resolution and may even endanger the whole global eco system.

Many stress that higher education and ICT may provide answers.

Some like Kurzweil even have a strong belief in this: *That merging of humans and machines is the essence of the Singularity, an era in which our intelligence will become increasingly non biological and trillions of times more powerful than it is today—the dawning of a new civilization that will enable us to transcend our biological limitations and amplify our creativity. In this new world, there will be no clear distinction between human and machine, real reality and virtual reality. We will be able to assume different bodies and take on a range of personae at will. In practical terms, human aging and illness will be reversed; pollution will be stopped; world hunger and poverty will be solved. Nanotechnology will make it possible to create virtually any physical product using inexpensive information processes and will ultimately turn even death into a soluble problem.*

Paul Allen has a somewhat less stronger belief in the way humans will transform but acknowledges the necessity of education to improve our capacity to resolve the challenges (Allen, 2011).

4.2 Broadband as a physical health threat

ICT in education will rely for a great deal on broadband. This can only be sustainable, if the use of broadband has no major short- or long-term risks for our physical health including procreation.

There are statements that RF used for mobile phone communication may have some unknown risks which should be monitored very careful. In 2003, Salford found damaged rat nerve cells after exposure to microwaves from GSM mobile phones. Since than many other indications have been found on biological effects on mice and other animal models regarding learning capability (Zhang, 2014) and even a possible effect on fertility (Adams, 2014) as well as carcinogenetic of UMTS wavelengths of RF, that may raise serious questions about the use of mobile phones and UMTS health concerns for humans. Further examination is required to see what long term effects can occur and which specific risks there may be.

4.3 ICT a psychological health threat

The same applies for the psychological health. Some research indicates that ICT use may lead to psychological health threats, Danielle Maras (Maras et al., 2015) provides for instance some evidence for the relation between the time spent in front of a screen and depression.

4.4 Threat of physical disturbance of the internet

It is known that solar bursts can cause an enormous disruption of ICT facilities and therefore affect also educational systems that are relying on this.

5 Policy and Institutional Trends

5.1 Privatization of higher education, world market increasing fees, HE for the wealthy

As obvious from 3.9, the countries charging high private contribution make explicit and deliberate choices. Further analysis of the OECD data from the OECD Factbook 2014 shows that privatization is not directly connected to exceeding public costs of Higher Education, but rather with local political preferences or culture, which can be seen best in the segment of countries where 15 000 to 20 000 USD per student is spent, see second chart in 3.8. If no social arrangements are made to stimulate the poorer parts of the population these policies can be regarded to be directed to inequity especially as the costs of education rise like in the USA (see 3.9.)

5.2 Increasing student loan debts in Anglo-Saxon countries and declining economic prospects of grades

The student loan debt in countries with a large share of privatization of the Higher Education as the USA, Canada, Australia and New Zealand is still increasing. In the USA the debt is now rising above the debt that caused the subprime loan crisis.

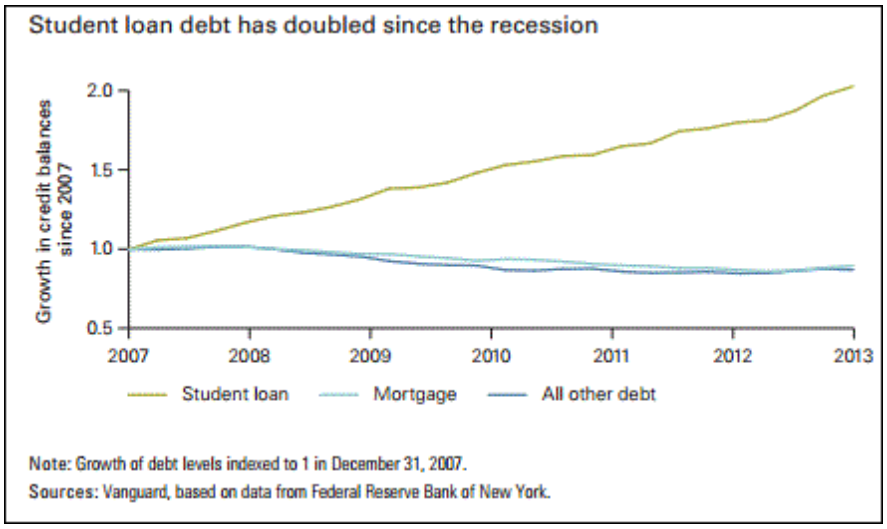


Fig. 29.

5.3 Efforts to increase higher education enrollment in upcoming economies

ICT seems to be embraced as a possibility to enhance the access to education in Countries as China (see Figs. 14 and 15).

5.4 Gradual acceptance of ICT literacy as one of the basic enabling literacies

The GRALE 2012 examines the way literacy is perceived in different countries. ICT skills are gradually incorporated in the literacy thinking, but mainly in Europe and the USA (see Fig. 31).

Keywords used in literacy definitions (reading, writing and numeracy combined)

	Reading and writing	Reading, writing and numeracy	Total with combined definitions/ total countries reported
Africa	4	15	19/31
Arab States	1	4	5/9
Asia and the Pacific	4	8	12/24
Europe and North America	10	13	23/40
Latin America and the Caribbean	8	6	14/25
Total	**27**	**46**	**73/129**

Source: National progress reports for GRALE 2012; Responses to Question 1.2 "Has your country adopted or developed an official definition of literacy?" and Question 1.2.1 "Are other definitions used in practice?"

Fig. 30.

Table 1.4
Other keywords used in literacy definitions

	ICT skills	Life skills	Language skills	Critical thinking	Autonomy/ empowerment	Total [15]
Africa	0	2	5	2	5	**31**
Arab States	0	0	1	0	0	**9**
Asia and the Pacific	1	2	8	1	1	**24**
Europe and North America	9	1	5	0	2	**40**
Latin America and the Caribbean	1	0	2	0	10	**25**
Total	**11**	**5**	**21**	**3**	**18**	**129**

Source: National progress reports for GRALE 2012; Responses to Question 1.2 "Has your country adopted or developed an official definition of literacy?" and Question 1.2.1 "Are other definitions used in practice?"

Fig. 31.

More important is that OECD (2013) distinguishes three main classes of literacy: genuine "literacy", which covers reading and writing, "numeracy" defined as access, use, interpreting and communication of mathematical information and ideas in order to engage in and manage the mathematical demands of a range of situations in adult life, and "problem solving in technology-rich environments among adults", which is defined as using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks.

The OECD Outlook (2013) provides the first comparative sets of test outcomes of what can be considered as a first rough set of ICT literacy skills.

5.5 Weakening of institutional boundaries

ICT and the new ways people can learn are concerned with the tendency to weaken former institutional boundaries even across country borders and have governance implications.

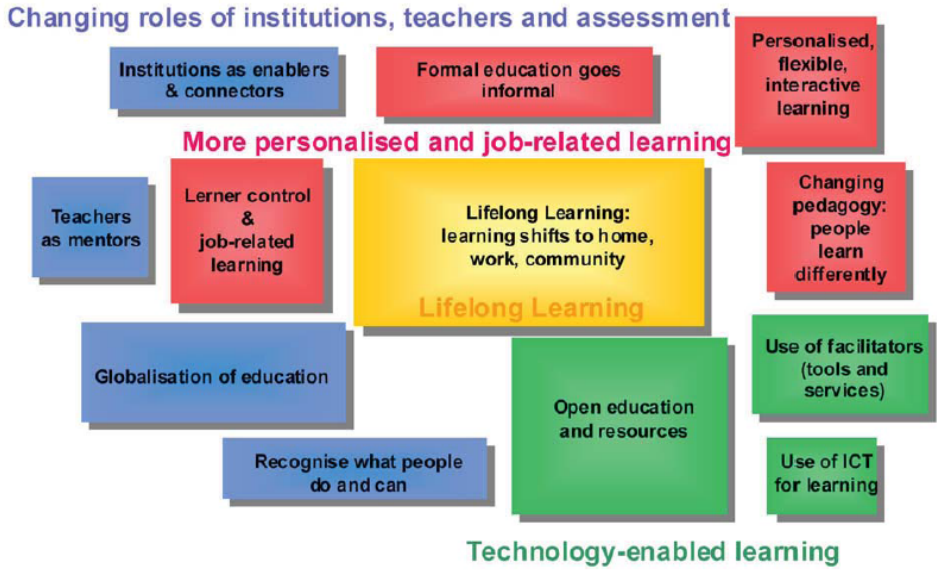


Fig. 32. Source: Redecker et al., 2011

5.6 Internet of People and Things is threatening our rights

Cloud applications store our data, but also make it possible to track and follow our virtual activities and real activities when we access the internet. The Internet of Things and of RFIDs increases the possibilities to track people and objects even without active contact with the internet with huge consequences for privacy (Kranenburg & Dobson, 2008).

5.7 ICT dependency as security risk

http://www.scribd.com/doc/240715227/Global-education-Roger-Dale#scribd

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